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House Committee on Science
Subcommittee on Energy

Chairman Biggert, ranking Member Honda, and members of the committee, I would like to thank you for the opportunity to speak before the Committee on Science, Subcommittee on Energy concerning United States and international efforts to develop and demonstrate advanced spent fuel separations and recycling technologies. Also, I thank you for your leadership in the area of nuclear energy technologies and for your interest in pursuing solutions to the Nation's challenges with the disposition of commercial spent nuclear fuel.

As you know, the President's 2001 National Energy Policy recommended the expansion of nuclear energy in this country to reduce our dependence on imported fuels needed for electricity generation and to reduce emissions. To meet these challenges, we must develop and apply advanced technologies, including advanced nuclear fuel cycles and next generation reactor technologies, and development of advanced fuel treatment technologies. These efforts are aimed at developing new advanced proliferation-resistant spent fuel treatment technologies to reduce the amount of commercial high level waste and spent fuel requiring storage in a geologic repository. If successful, these efforts could substantially improve repository capacity. In the longer term future, these technologies in combination with advanced nuclear reactor technologies hold the promise of deferring, perhaps indefinitely, the need for a second repository, while reducing the inventory of civilian plutonium.

My testimony today focuses on U.S. efforts to develop new advanced separations technologies – technologies that are more efficient, less waste intensive and more proliferation resistant – our progress in developing these technologies, and additional work that is needed to demonstrate commercial viability of these technologies. While the United States is a leader in development of these technologies, it is important to recognize that other nations (*e.g.*, France, Japan, the United Kingdom, China, India, and Russia) with domestic nuclear programs are also investigating these technologies. Collaborations are also underway between the United States and several of these countries. A fundamental objective of U.S. collaborations is development of advanced proliferation resistant fuel cycle technologies that will set the standard for future international deployment of fuel cycle facilities.

BACKGROUND

The policy underpinnings of the Department of Energy's Advanced Fuel Cycle Initiative and its program for international cooperation with other countries is contained in the May 2001 National Energy Policy, which states that:

> "…in the context of developing advanced nuclear fuel cycles and next generation technologies for nuclear energy, the United States should reexamine its policies to allow for research, development and deployment of fuel conditioning methods that reduce waste streams and enhance proliferation resistance. In doing so, the United States will continue to discourage the accumulation of separated plutonium, worldwide."

The policy further states that the United States should consider technologies, in collaboration with international partners with highly-developed fuel cycles and a record of close cooperation, to develop fuel treatment technologies that are cleaner, more efficient, less waste-intensive, and more proliferation-resistant.

Inherent in this recommendation is the recognition that regardless of anticipated growth in nuclear generation, the Nation needs to establish a permanent geological repository for spent nuclear fuel from the operation of our existing commercial nuclear power plants. Further, growth in nuclear energy in the United States using the current spent fuel management approach would require construction of additional geologic repositories to address spent nuclear fuel inventories generated by the operation of additional nuclear power plants. However, development of advanced separations technologies present a potential alternative to building new repositories, optimizing the current geologic repository, and enabling more efficient use of our nuclear fuel resources.

As such, separations technologies are under development in the United States and by other countries to reduce the volume, toxicity, and fissile material content of spent nuclear fuel requiring the disposal in a permanent geologic repository. These advanced technologies are aimed at avoiding the proliferation issues associated with separated plutonium while resulting in significantly smaller quantities of high-level radioactive waste, enabling optimization of the geological repository.

These new technologies present a significant advantage in proliferation resistance over existing separations technologies being used in other parts of the world today and which were used previously in the United States- the Plutonium-Uranium Extraction (PUREX) technology. PUREX is an aqueous separations process that was deployed initially in the mid-1950s to recover high purity plutonium and uranium from fission products and minor transuranic elements (elements heavier than uranium). PUREX has been deployed commercially in several countries - principally France, the United Kingdom, Japan and Russia.

In the future, we believe that advanced separations technologies, such as URanium EXtraction Plus (UREX+), could enable us to further extend the useful life of any geologic repository and reduce the radiotoxicity of the waste it contains such that it would decay to the toxicity of natural uranium ore in less than 1,000 years—instead of over 100,000 years as is the case with our current, untreated spent nuclear fuel. This technology could also allow our nuclear plants to use a far higher fraction of the energy contained in uranium ore, potentially expanding the lifetime of the world's nuclear fuel resources from around 100 years up to 1,000 years.

DEVELOPMENT OF INNOVATIVE SEPARATIONS TECHNOLOGIES

Over the last several years, the Department's Advanced Fuel Cycle Initiative has made significant progress in the development of new fuel treatment technologies, particularly as applied to the development of the UREX+ technology, a technology that separates uranium from spent nuclear fuel at a very high level of purity. This is important because it demonstrates the feasibility of greatly reducing the mass of material that would require disposal in a geologic repository. The research has also successfully demonstrated the ability to separate the short-term heat generating constituents of spent fuel and the partitioning of the transuranic elements. Unlike the PUREX process, the UREX+ process does not produce a separated plutonium product which provides a considerable advantage in reducing proliferation risk.

Presently, the Department has demonstrated the feasibility of the UREX+ process based on laboratory-scale tests using actual spent nuclear fuel. While the results from our laboratory-scale tests coupled with general industrial-scale experience could provide a high level of confidence that the general direction being recommended is technically feasible, integrated processing experiments carried out successfully at a larger engineering-scale would be needed before there is sufficient information to design and build new facilities or make needed major modifications to existing facilities for commercial-scale operations.

While the UREX+ process has great potential to address the spent fuel challenges associated with today's commercial light water reactors, the Department has also been investigating an alternative separations technology called pyroprocessing, which is more appropriate for treating advanced fuels from fast reactors like those under investigation in the Department's Generation IV reactor program that may be developed and deployed in the long-term future. The pyroprocessing technology employs high-temperature operations that use selective reduction and oxidation in molten salts and metals to recover nuclear materials. The pyrochemical processing technology is also supportive of nonproliferation objectives in that the resulting separated fuel material is adequate for use in fueling advanced fast-neutron spectrum reactors but represents a significant reduction in proliferation risk as the plutonium remains mixed with the other transuranic elements and fission products. The largest scale application of this technology is found at the Idaho National Laboratory where engineering-scale treatment of sodium-bonded spent nuclear fuel from the shutdown Experimental Breeder Reactor II has provided several years of research and operations data. At maximum capacity, this engineering-scale demonstration is capable of processing up to three metric tons of spent nuclear fuel annually.

DEVELOPMENT OF ADVANCED FUEL CYCLE TECHNOLOGIES

The United States presently employs a once-through fuel cycle – that is, the spent fuel is not recycled but rather discharged from the reactor and maintained in interim storage at the reactor site pending future shipment to a geologic repository. However, as discussed previously, a number of countries operate a partially closed fuel cycle in that the plutonium is

removed from the spent fuel at a reprocessing facility and is sent to a fuel fabrication facility to be blended with fresh uranium and re-fabricated into mixed oxide (MOX) fuel pellets. The pellets are placed into cladding material and bundled into fuel assemblies for subsequent return to light water reactors capable of using MOX as fuel. The other spent fuel constituents are immobilized in glass for storage in a geologic repository. The Department is pursuing an approach similar to this one used by other countries to create MOX from surplus weapons grade plutonium.

The Department's Advanced Fuel Cycle Initiative fuels development includes proliferation-resistant fuels for light water reactors, fuels that will enable transmutation of transuranics in Generation IV reactors, and all fuels for the fast reactor group of Generation IV reactors. The objective of these technologies is to avoid separating plutonium in a pure form. The resultant mixed oxide fuel would contain some or all of the minor actinides (neptunium, americium and curium) contained in the spent fuel to enhance its proliferation resistance and allow for further reductions in the volume and radiotoxicity of the resulting high-level wastes. In each of these technologies, the benign residual fission products would be sent to a geologic repository with the exception of iodine-129 and strontium/cesium which would be disposed by means other than a geologic repository. These approaches are anticipated to increase the effective capacity of a geologic repository by a factor of 50 to100.

In fast reactor scenarios, actinides from spent fuel can be processed to separate them from the bulk of the fission products and uranium. The actinide stream can then be used to manufacture fuel for use in fast reactors. Because the fuel is highly radioactive, the fuel fabrication process must be conducted in shielded facilities, conferring an additional degree of proliferation resistance.

Commercial scale-up of these spent fuel technologies can, based on our recent analysis, be performed relatively rapidly, if existing domestic facilities could be substantially modified and utilized. Using existing facilities, engineering-scale verification experiments for a chosen separation technology could be underway in five to six years and commercial-scale operations could begin in ten to twelve years. Fuel fabrication experiments and commercial-scale operations would lag the demonstration of the separations technology by two to four years. However, retrofitting existing structures to demonstrate commercial viability of spent fuel treatment presents numerous technical and regulatory challenges and may not be the most reasonable approach. For example, a down-side to retrofitting existing structures would be the current age of the structure and inherent inflexibilities such as the introduction and testing of modern instrumentation for process control, accountability and proliferation resistance.

An alternate scenario could be to build a "greenfield" engineering-scale demonstration facility that could provide assurance of the commercial viability of spent fuel treatment and fuel fabrication technologies. If both the engineering-scale and commercial-scale operations were conducted in new facilities designed from the ground up, engineering-scale experiments of a selected separations process could begin in approximately nine years and commercial operation, in about twenty. Again, fuel fabrication would lag by two to four years.

CONCLUSION

Over the last few years, the Department has successfully demonstrated the technical feasibility of advanced, proliferation-resistant fuel cycle technologies. Engineering-scale demonstrations, however, are needed to demonstrate with reasonable confidence the commercial feasibility of these technologies. We look forward to working closely with the Congress on the key issue of spent nuclear fuel management today and in the future.

I would be pleased to answer any questions you may have.